

**ACCELERATION SENSOR ASSEMBLY FOR RESTRAINT RETRACTOR**

5 **TECHNICAL FIELD**

The present invention relates generally to seat restraint systems for vehicles and, more particularly, to an acceleration sensor assembly for a restraint retractor of a seat restraint system in a vehicle.

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**BACKGROUND OF THE INVENTION**

It is known to provide a seat restraint system such as a seat belt in a vehicle to restrain an occupant in a seat of the vehicle. In some vehicles, the seat  
15 restraint system may be a lap belt, a shoulder belt or both. Typically, the lap belt and shoulder belt are connected together at one end. The seat restraint system includes a latch plate at the connected end. The seat restraint system also includes a buckle connected at one  
20 end by webbing or the like to vehicle structure. The buckle receives the latch plate to be buckled together. When the buckle and latch plate are buckled together, the seat restraint system restrains movement of the occupant to help protect the occupant during a collision.

25 It is also known to provide a restraint retractor for the seat restraint system. Typically, the

restraint retractor has a spool attached to belt webbing of the seat restraint and is rotatably mounted to the restraint retractor by a shaft. The restraint retractor has a spiral spring on one end of the shaft to urge the  
5 spool in a direction for retracting the belt webbing when not in use. Also, the restraint retractor has a toothed locking sprocket on the other end of the shaft and a locking pawl to engage the sprocket to lock the shaft against rotation in the other direction to prevent belt  
10 webbing unwinding. The locking sprocket is typically slaved to an acceleration sprocket via a spring and an acceleration pawl is actuated by an acceleration sensing mechanism or sensor. The acceleration sensor includes a mass member or "standing man" that may be spherically  
15 shaped or frusto-conical in shape to engage and actuate the acceleration pawl.

The restraint retractor may be attached to the seat or vehicle body. In an "all belts to seat" or "seat integrated restraint" application, the restraint retractor  
20 is attached to a frame of a seat back of the seat. When the restraint retractor is attached to the seat, the acceleration sensor is sensitive and the mass member is easily activated, such as when the seat back is reclined, thereby actuating the acceleration pawl to engage the  
25 acceleration sprocket and operatively causing the locking sprocket and locking pawl to engage via the spring to lock

the shaft of the restraint retractor against rotation.  
This condition is undesired.

To overcome this condition, some restraint retractors have been provided with a two mass system to  
5 actuate the acceleration pawl. In the two mass system, a  
big mass is provided, which lags a small mass that  
actuates the acceleration pawl. However, these restraint  
retractors have a high noise level, bulky package, and  
decreased sensitivity on low speed decelerations (pre-  
10 impact braking).

Therefore, it is desirable to provide an  
acceleration sensor for a restraint retractor of a seat  
restraint system in a vehicle for an "all belts to seat"  
application to allow acceleration sensing. It is also  
15 desirable to provide an acceleration sensor for a  
restraint retractor of a seat restraint system in a  
vehicle that has higher sensitivity to low speed  
decelerations (pre-impact braking). It is further  
desirable to provide an acceleration sensor for a  
20 restraint retractor of a seat restraint system in a  
vehicle that reduces noise and packaging size. It is  
still further desirable to provide a seat integrated  
vehicle sensing mechanism that allows a vehicle seatback  
to recline at a predetermined range of angle while  
25 maintaining its sensitivity and effectiveness.

**SUMMARY OF THE INVENTION**

Accordingly, the present invention is an acceleration sensor assembly for a restraint retractor of a seat restraint system including an acceleration sprocket  
5 operatively connected to the restraint retractor. The acceleration sensor assembly also includes an acceleration pawl cooperating with the acceleration sprocket to operatively cause lock up of the restraint retractor. The acceleration sensor assembly includes an inertia member  
10 cooperating with the acceleration pawl to move the acceleration pawl when an acceleration force is present and a gimbal to support the inertia member. The acceleration sensor assembly further includes a non-contact damping mechanism cooperating with the gimbal to  
15 dampen movement of the gimbal until the acceleration force exceeds a predetermined value and the inertia member actuates the acceleration pawl to engage the acceleration sprocket to operatively cause lock up of the restraint retractor and prevent unwinding of a belt from the  
20 restraint retractor.

One advantage of the present invention is that an acceleration sensor assembly is provided for a restraint retractor of a seat restraint system in a vehicle for an "all belts to seat" or "integrated seat  
25 restraint" application to allow acceleration sensing. Another advantage of the present invention is that the

acceleration sensor assembly has a low noise level, eliminating extra cost for a bulky noise insulation cover. Yet another advantage of the present invention is that the acceleration sensor assembly has higher sensitivity to low speed decelerations (pre-impact braking). Still another advantage of the present invention is that the acceleration sensor assembly has a slender side profile to maintain compactness for the restraint retractor. A further advantage of the present invention is that the acceleration sensor assembly is lighter in mass. Yet a further advantage of the present invention is that the acceleration sensor assembly utilizes a magnetic damper on a gimbal mechanism to provide higher sensitivity, particularly at low speeds. Another advantage of the present invention is that the acceleration sensor assembly employs magnetic damping to provide a gimbal within a predetermined seatback angle range, better damping force on the gimbal during vehicle acceleration/deceleration, and superior sensitivity on vehicle acceleration sensor. Yet another advantage of the present invention is that the acceleration sensor assembly utilizes eddy current damping in conjunction with an inertia member that is quiet, compact, light weight, and cost effective.

Other objects, features, and advantages of the present invention will be readily appreciated, as the same becomes better understood, after reading the subsequent

description taken in conjunction with the accompanying drawings.

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#### BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 is a perspective view of an acceleration sensor assembly, according to the present invention, illustrated in operational relationship with a  
10 seat restraint system of a vehicle.

Figure 2 is a side elevational view of the acceleration sensor assembly and a restraint retractor of the seat restraint system of Figure 1.

Figure 3 is a fragmentary view of a portion of  
15 the restraint retractor of Figure 2.

Figure 4 is a perspective view of the acceleration sensor assembly of Figure 1.

Figure 5 is a front elevational view of the acceleration sensor assembly of Figure 4.

20 Figure 6A is a perspective view of another embodiment, according to the present invention, of the acceleration sensor assembly of Figure 4.

Figure 6B is a perspective view of yet another embodiment, according to the present invention, of the  
25 acceleration sensor assembly of Figure 4.

Figure 6C is a perspective view of still another embodiment, according to the present invention, of the acceleration sensor assembly of Figure 4.

Figure 6D is a perspective view of a further  
5 embodiment, according to the present invention, of the acceleration sensor assembly of Figure 4.

Figure 6E is a perspective view of a still further embodiment, according to the present invention, of the acceleration sensor assembly of Figure 4.

10 Figure 7A is a side elevational view of the acceleration sensor assembly of Figure 6A.

Figure 7B is a view similar to Figure 7A illustrating the acceleration sensor assembly in a first operational state.

15 Figure 7C is a view similar to Figure 7A illustrating the acceleration sensor assembly in a second operational state.

#### DESCRIPTION OF THE PREFERRED EMBODIMENT

20 Referring to the drawings and in particular Figures 1 and 2, one embodiment of an acceleration sensor assembly 10, according to the present invention, is shown for a seat restraint system, generally indicated at 12, in a vehicle (partially shown), generally indicated at 14.  
25 The vehicle 14 includes a vehicle body 16 and a seat 18 mounted by suitable means to vehicle structure 20 such as

a floorpan in an occupant compartment 22 of the vehicle body 16. In this embodiment, the seat 18 is a front seat of the vehicle 14. The seat 18 has a seat cushion 18a and a seat back 18b pivotally connected to the seat cushion 18a by suitable means (not shown). It should be appreciated that the seat 18 could be a rear, second row or third row seat for the vehicle 14.

The vehicle 14 includes the seat restraint system 12 for restraining an occupant (not shown) in the seat 18. The seat restraint system 12 includes a latch tongue or plate 24 connected to an end of either one of a lap belt 26, shoulder belt 28, or both which have another end connected to a restraint retractor 34 to be described. The seat restraint system 12 also includes a buckle assembly 30 connected by suitable means such as belt webbing 32 to the vehicle structure 20. The latch plate 24 is engageable and disengageable with the buckle assembly 30 as is known in the art. It should be appreciated that, except for the acceleration sensor assembly 10, the seat restraint system 12 and vehicle 14 are conventional and known in the art.

Referring to Figures 2 and 3, the seat restraint system 12 includes a restraint retractor, generally indicated at 34, connected to the shoulder belt 28. The restraint retractor 34 includes a housing 36 having a base wall 38 and spaced apart sidewalls 40. The restraint



retractor 34 also includes a belt reel or take-up spool 42 disposed between the sidewalls 40 and connected by suitable means to the end of the shoulder belt 28. The restraint retractor 34 also includes a shaft 44 extending  
5 through the take-up spool 42 and the sidewalls 40 of the housing 36 such that the take-up spool 42 is rotatable relative to the housing 36. It should be appreciated that the housing 36 is attached by suitable means (not shown) to a frame (not shown) of the seat back 18b for the seat  
10 18.

The restraint retractor 34 also includes a retractor spring 46 disposed about one end of the shaft 44. The retractor spring 46 is of a spiral type having one end attached to the shaft 44 and another end connected  
15 to the housing 36 as is known in the art. The retractor spring 46 may be enclosed by a spring housing 47 attached to the sidewall 40 of the housing 36. The retractor spring 46 has a predetermined torque or tension and urges the shaft 44 in a predetermined direction to wind up the  
20 shoulder belt 28 on the take-up spool 42. It should be appreciated that the restraint retractor 34 may have a structure similar to that disclosed in U.S. Patent No. 4,815,674 to Blake et al.

The restraint retractor 34 also includes a  
25 locking sprocket 48 attached to and rotatable with the other end of the shaft 44 opposite the spring 46. The

locking sprocket 48 has a plurality of teeth 49 disposed circumferentially thereabout. The restraint retractor 34 includes a locking pawl 50 pivotally connected to a side wall 40 of the housing 36 by suitable means such as a pin (not shown). The locking pawl 50 is engageable with the teeth 49 to lock the shaft 44 relative to the housing 36. The restraint retractor 34 also includes a guide member 51 disposed about the shaft 44 and has a locking arm (not shown) engageable with the teeth 49 on the locking sprocket 48 and a slot (not shown) extending therethrough to receive a pin 52 extending from the locking pawl 50 and received in the slot. When the belt webbing of the shoulder belt 28 is unwound above a predetermined rate, the locking arm engages the teeth 49 to rotate the guide member 51 and move the slot relative to the pin 52, causing the locking pawl 50 to pivot and engage the teeth 49 to lock the shaft 44 against rotation. It should be appreciated that the restraint retractor 34 is conventional and known in the art.

Referring to Figures 2, 4, and 5, the acceleration sensor assembly 10, according to the present invention, includes an acceleration sprocket or disc 53 attached to and disposed about the end of the shaft 44 of the restraint retractor 34. The acceleration sprocket 53 is generally circular in shape and has a plurality of teeth 54 disposed circumferentially thereabout. The

sprocket 53 is connected to the locking sprocket 48 via a spring (not shown) such that the acceleration sprocket 53 can rotate with the locking sprocket 48 at the same speed or relative thereto at different speeds. It should be appreciated that the acceleration sprocket 53 is a slave type member.

The acceleration sensor assembly 10 also includes a support housing 55 connected by suitable means to the retractor housing 36. The support housing 55 is generally rectangular in shape. The support housing 55 has a base wall 56 and opposed side walls 57 extending generally perpendicular to the base wall 56 to form a cavity 58 therein. The support housing 55 has a projection 60 extending from one of the side walls 57 for connection to the retractor housing 36. The support housing 55 also has a pair of opposed cavities 61 extending into the side walls 57 near a top thereof for a function to be described. The support housing 55 has a pair of apertures (not shown) extending laterally through the sidewalls 57 and spaced vertically from the cavities 61 near a top thereof. The support housing 55 is made of a rigid material, preferably a plastic material. The support housing 55 is a monolithic structure being integral, unitary, and formed as one-piece.

The acceleration sensor assembly 10 also includes a gimbal 62 disposed in the cavity 58 of the

support housing 55. The gimbal 62 is generally "U" shaped and has a base wall 64 and opposed side walls 66 extending generally perpendicular to the base wall 64 to form a cavity 68 therein. The gimbal 62 has a projection 70  
5 extending laterally outwardly from each side wall 66 and disposed in the cavities 61 of the support housing 55 to connect and to allow pivotal movement of the gimbal 62 relative to the support housing 55. The gimbal 62 has a predetermined mass. The gimbal 62 is made of a rigid  
10 material such as plastic. It should be appreciated that the gimbal 62 may have any suitable shape. It should also be appreciated that the gimbal 62 acts as a swinging pendulum or plumb bob.

The acceleration sensor assembly 10 includes an  
15 out of range sensor 69 connected to the gimbal 62 on one of the side walls 66 for a function to be described. The out of range sensor 69 cooperates with a sensor lever 78 to be described to lock the restraint retractor 34 when the seat back 18b of the seat 18 is reclined outside a  
20 range of predetermined operating angles. The out of range sensor 69 will be described in more detail in connection with Figures 7A through 7C.

The acceleration sensor assembly 10 also includes an inertia member 72 such as a "standing man"  
25 disposed in the cavity 68 of the gimbal 62. The inertia member 72 is generally cylindrical in shape. The inertia

member 72 also has a recess 74 in an upper end thereof. The recess 72 is arcuate in shape for a predetermined curve for certain range of acceleration from approximately 0.26 to approximately 0.7 G's, preferably approximately 0.4 G's, for a function to be described. The inertia member 72 has a predetermined mass that is different from the predetermined mass of the gimbal 62. The inertia member 72 is made of a metal material such as brass. It should be appreciated that the inertia member 72 may have any suitable shape such as a sphere.

The acceleration sensor assembly 10 includes an acceleration or sensor lever 78 extending longitudinally and having a tooth portion 80 extending outwardly from an end thereof for engaging the teeth 54 on the acceleration sprocket 53. The sensor lever 78 also has a cam surface (not shown) for cooperating with the out of range sensor 69 as described in connection with Figures 7A through 7C. The sensor lever 78 is pivotally connected to the support housing 55 by suitable means such as a pin 82 extending through the apertures of the support housing 55. The sensor lever 78 has a projection 84 extending toward the cavity 58 of the support housing 55 and is disposed in the recess 74 to engage the inertia member 72. The sensor lever 78 is made of a rigid material, preferably a plastic material. The sensor lever 78 is a monolithic structure being integral, unitary, and one-piece. It should be

appreciated that the sensor lever 78 may be a two-piece lever for a sphere shaped inertia member. It should also be appreciated that the projection 84 of the sensor lever 78 is positioned collinearly to a pivoting axis of the gimbal 62. It should be appreciated that, upon receiving an acceleration force, the inertia member 72 pivots to move the sensor lever 78 to engage the teeth 54 to stop rotation of the acceleration sprocket 53 to cause the locking pawl 50 via the spring to engage the teeth 49 on the locking sprocket 48 and lock the shaft 44 to prevent pay-out of the shoulder belt 28. It should further be appreciated that the acceleration sprocket 53 and locking sprocket 48 form a slave type system.

The acceleration sensor assembly 10 further includes a single magnet 86 disposed within the housing 55. The magnet 86 is of a Neodymium permanent or rare earth magnet type. The acceleration sensor assembly 10 also includes a single conductive member 90 connected to the base wall 64 of the gimbal 62. The conductive member 90 has a generally arcuate or curved shape. The conductive member 90 is a single plate made of a non-magnetic and electrically conductive material such as copper. The acceleration sensor assembly 10 also includes a focusing member 94 disposed in the housing 55 beneath the gimbal 62 and having a generally "U" shaped cross-section. The focusing member 94 is made of a flux

directing magnetic material. The focusing member 94 is secured to the housing 55 by suitable means. The magnet 86 is disposed below or beneath the conductive member 90 within the focusing member 94. It should be appreciated  
5 that the gimbal 62, magnet 86, and conductive member 90 form a non-contact or eddy current damping mechanism. It should also be appreciated that the focusing member 94 cooperates with the magnet 86 for magnetic field focusing and flux redirecting. It should further be appreciated  
10 that the magnet 86 and conductive member 90 form a horizontal arrangement.

In operation of the acceleration sensor assembly 10, when a sudden vehicle acceleration or deceleration is detected such as when the vehicle 14 is subjected to a "G"  
15 load from 0.26 G's to 0.7 G's, the dynamic motion of the gimbal 62 is dampened out by the magnetic interaction between the magnet 86 and the conductive member 90. This forces the inertia member 72 to tilt and exert an upwardly directed force on the projection 84 of the sensor lever  
20 78. The sensor lever 78 will in turn be lifted into its actuating position to engage the acceleration sprocket 53 to stop rotation thereof, in turn, causing the locking pawl 50 via the spring to engage the locking sprocket 48, locking-up the restraint retractor 34. When the G load is  
25 less than 0.26 G's, the inertia member 72 maintains its neutral position and the restraint retractor 34 is

unlocked when the shoulder belt 28 goes back into the restraint retractor 34. It should be appreciated that for an acceleration greater than the designed "G" load, the restraint retractor 34 will lock-up in a normal manner via  
5 the locking pawl 50 and locking sprocket 48.

When the seat back 18b of the seat 18 is reclined at a predetermined operating angle such as between a range of thirteen degrees ( $13^\circ$ ) to thirty-five degrees ( $35^\circ$ ), preferably minus twenty-five degrees ( $-25^\circ$ )  
10 to positive twenty-five degrees ( $25^\circ$ ), the gimbal 62 and its attached components will rotate to a fixed resting position where the combined center of mass is always pointed towards the center of gravity and prevents the restraint retractor 34 from locking up. In the case where  
15 the seat back 18b of the seat 18 is reclined outside the range of the predetermined operating angles, the out of range sensor 69 will exert an upwardly directed force on the sensor lever 78, lifting its pawl into the actuating position. It should be appreciated that the out of range  
20 sensor 69 will be described in more detail in relation to Figures 7A through 7C. It should also be appreciated that, when the seat back 18b of the seat 18 is reclined within the range of the predetermined operating angles, the gimbal 62 maintains the inertia member 72 in a  
25 position that will not lock up the restraint retractor 34. It should further be appreciated that the acceleration



sensor assembly 10 allows the seat back 18a to recline at predetermined angles while maintaining the sensitivity and effectiveness of the acceleration sensor assembly 10. It should still further be appreciated that the acceleration  
5 sensor assembly 10 does not lock the restraint retractor 34 to any angle fifteen degrees (15°) or less from its orientation in the vehicle (0.26 G's or less) and locks to any angle forty-five degrees (45°) or greater from its orientation in the vehicle (0.7 G's or more).

10 Referring to Figure 6A, another embodiment, according to the present invention, of the acceleration sensor assembly 10 is shown. Like parts of the acceleration sensor assembly 10 have like reference numerals increased by one hundred (100). In the  
15 embodiment illustrated in Figure 6A, the acceleration sensor assembly 110 includes the conductive member 190 disposed beneath the gimbal 162 and having a generally "U" shaped cross-section. The conductive member 190 is secured to the housing 155 by suitable means. The  
20 acceleration sensor assembly 110 includes at least one magnet 186 connected to an "L" shaped projection 171 extending from the gimbal 162 and disposed within the conductive member 190. The acceleration sensor assembly 110 further includes the inertia member 172, out of range  
25 sensor 169, and sensor lever 178. It should be appreciated that the operation of the acceleration sensor

assembly 110 is similar to the acceleration sensor assembly 10. It should also be appreciated that the magnet 186 and conductive member 190 have a horizontal arrangement. It should further be appreciated that the  
5 acceleration sensor assembly 110 has an overall height reduction compared to the acceleration sensor assembly 10.

Referring to Figure 6B, yet another embodiment, according to the present invention, of the acceleration sensor assembly 10 is shown. Like parts of the  
10 acceleration sensor assembly 10 have like reference numerals increased by two hundred (200). In the embodiment illustrated in Figure 6B, the acceleration sensor assembly 210 includes a single magnet 286 connected to the base wall 264 of the gimbal 262. The acceleration  
15 sensor assembly 210 also includes a single conductive member 290 disposed below or beneath the magnet 286. The conductive member 290 has a generally arcuate or curved shape. The conductive member 290 is a single plate. The conductive member 290 is secured to the housing 255 by  
20 suitable means. The acceleration sensor assembly 210 further includes the inertia member 272, out of range sensor (not shown), and sensor lever 278. It should be appreciated that the operation of the acceleration sensor assembly 210 is similar to the acceleration sensor  
25 assembly 10. It should also be appreciated that the magnet 286 and conductive member 290 have a horizontal

arrangement. It should further be appreciated that the acceleration sensor assembly 210 has an overall height reduction compared to the acceleration sensor assembly 10 and is compact.

5 Referring to Figure 6C, still another embodiment, according to the present invention, of the acceleration sensor assembly 10 is shown. Like parts of the acceleration sensor assembly 10 have like reference numerals increased by three hundred (300). In the  
10 embodiment illustrated in Figure 6C, the acceleration sensor assembly 310 includes a single conductive member 390 connected to the base wall 364 of the gimbal 362. The acceleration sensor assembly 310 also includes a single magnet 386 disposed below or beneath the conductive member  
15 390. The magnet 386 is secured to the housing 355 by suitable means. The acceleration sensor assembly 310 further includes the inertia member 372, out of range sensor (not shown), and sensor lever 378. It should be appreciated that the operation of the acceleration sensor  
20 assembly 310 is similar to the acceleration sensor assembly 10. It should also be appreciated that the magnet 386 and conductive member 390 have a horizontal arrangement. It should further be appreciated that the acceleration sensor assembly 310 has a reverse  
25 magnet/electric conductive member configuration compared to the acceleration sensor assembly 210.

Referring to Figure 6D, a further embodiment, according to the present invention, of the acceleration sensor assembly 10 is shown. Like parts of the acceleration sensor assembly 10 have like reference numerals increased by four hundred (400). In the embodiment illustrated in Figure 6D, the acceleration sensor assembly 410 includes the gimbal 462 having a projection 471 extending axially from the base wall 464 for a function to be described. The acceleration sensor assembly 410 further includes at least one magnet 486 mounted to the projection 471 of the gimbal 462 by suitable means such as an adhesive (not shown) or press-fit into an aperture 488 extending therethrough. The acceleration sensor assembly 410 includes at least one, preferably a pair of the conductive members 490 disposed in the support housing 455 and spaced laterally. The conductive members 490 are generally planar and "U" shaped. The conductive members 490 are mounted to the support housing 455 by suitable means such as an adhesive (not shown) such that the magnet 486 is disposed between the conductive members 490. The acceleration sensor assembly 410 further includes the inertia member 472, out of range sensor (not shown), and sensor lever 478. The out of position sensor is used for  $\pm 20$  degrees gimbal range with five degrees out of position kickoff. It should be appreciated that the gimbal 462, magnet 486, and

conductive members 490 form a non-contact or eddy current damping mechanism. It should also be appreciated that the operation of the acceleration sensor assembly 410 is similar to the acceleration sensor assembly 10. It should  
5 further be appreciated that the magnet 486 and conductive members 490 form a vertical arrangement.

Referring to Figure 6E, a still further embodiment, according to the present invention, of the acceleration sensor assembly 10 is shown. Like parts of  
10 the acceleration sensor assembly 10 have like reference numerals increased by five hundred (500). In the embodiment illustrated in Figure 6E, the acceleration sensor assembly 510 includes the focusing member 594 disposed beneath the gimbal 562 and having a generally "U"  
15 shaped cross-section. The focusing member 594 is secured to the housing 555 by suitable means. The acceleration sensor assembly 510 includes a single conductive member 590 connected to the base wall 564 of the gimbal 562. The electric conductive member 590 is a single plate. The  
20 acceleration sensor assembly 510 includes a single magnet 586 disposed below or beneath the gimbal 562 within the focusing member 594. The acceleration sensor assembly 510 further includes the inertia member 572, out of range sensor (not shown), and sensor lever 578. It should be  
25 appreciated that the operation of the acceleration sensor assembly 510 is similar to the acceleration sensor

assembly 10. It should also be appreciated that the magnet 586 and conductive member 590 have a vertical arrangement. It should further be appreciated that the acceleration sensor assembly 510 has magnetic focusing and  
5 flux redirecting. It should still further be appreciated that these various embodiments of the acceleration sensor assembly provide flexibility to package the acceleration sensor assembly according to retractor type and location preference.

10 Referring to Figures 7A through 7C, the acceleration sensor assembly 110 is shown. The acceleration sensor assembly 110 includes the out of range sensor or projection 169 that is similar to the out of range sensor 69. The out of range sensor 169 has a  
15 forward or first projection 197 and a rear or second projection 199. As illustrated in Figure 7A, the out of range sensor 169 is shown in a non-actuating position such as zero degrees. In the case where the seat back 18b of the seat 18 is reclined rearward outside the range of the  
20 predetermined operating angle ( $\theta$ ) such as minus twenty five degrees, the first projection 197 of the out of range sensor 169 cooperates with the cam surface 181 on the sensor lever 178 to exert an upwardly directed force for cam action on the sensor lever 178, lifting its pawl into  
25 the actuating position as illustrated in Figure 7B. In the case where the seat back 18b of the seat 18 is

reclined forward outside the range of the predetermined operating angle ( $\theta$ ) such as positive twenty five degrees, the second projection 199 of the out of range sensor 169 will contact the sensor lever 178 to exert an upwardly  
5 directed force for direct action on the sensor lever 178, lifting its pawl into the actuating position as illustrated in Figure 7C. It should be appreciated that the out of range sensor and sensor lever operate similarly for the various embodiments of the acceleration sensor  
10 assembly.

The present invention has been described in an illustrative manner. It is to be understood that the terminology, which has been used, is intended to be in the nature of words of description rather than of limitation.

15 Many modifications and variations of the present invention are possible in light of the above teachings. Therefore, within the scope of the appended claims, the present invention may be practiced other than as specifically described.